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Has the COVID-19 pandemic altered the frequency of periodontitis? An analysis conducted using Google Trends

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ABSTRACT

Aims: The aim of this study is to compare the frequency of searches for the word "periodontitis" on the internet in the period after SARS-CoV-2 infection and in the previous period, using GT (Google Trends), and in this way to indirectly determine whether there is a relationship between SARS-CoV-2 infection and periodontitis.

Methods: Using the GT online tool in randomly selected countries and around the world, the word "periodontitis" and the word equivalent to the word "periodontitis" in the language of that country were scanned for a 4-year period before and after the SARS-CoV-2 pandemic and compared.

Results: The M (mean) of the RSV data of the word "periodontitis" worldwide in the pre-Covid period (between 2015-2019) in Google Trends was detected as 64.11±7.85, MD (median) was 63, and min and max were 44 and 100, respectively.

Conclusion: In this study, it has been determined that the level of internet searches for the word "periodontitis" has increased compared to the pre-SARS-CoV-2 period since the first occurrence of the SARS-CoV-2 virus worldwide. This study may provide a causal basis for subsequent clinical studies on this subject.

Keywords: Google Trends, periodontitis, SARS-CoV-2 infection

INTRODUCTION

The Internet has rapidly become a primary source for information on health.[1] Millions of individuals search for health-related information every day around the world. Through keyword-based internet searches, users can quickly access a large amount of information.[2] The majority of health-related searches on the internet consists of searching for specific health problems, joining an online health-related support group and searching for someone else's illness or important health problem.[3] When examining people's search habits related to health, it is observed that these searches are mainly conducted using various search engines such as Google, Yahoo!, Bing, and Ask.com.[1] Recent studies suggest that internet search behaviour could be beneficial in predicting public health events.[4] In 2004, Google Inc. developed a tool called Google Trends (GT), which revolutionized free access to web-based interactive search.[5] In addition to its extensive utilization in marketing, sales and advertising, GT also has great potential for scientific studies on oral health.[1,6-8] In the first study where GT was used, researchers tried to predict the flu based on geography and time.[9] Following this study, GT has been used in numerous medical studies not only to predict pandemic diseases like influenza but also to forecast the geographical location and seasonal behaviour of various diseases.[9-13] The emergence of SARS-CoV-2 as a new human pathogen in December 2019 caused major changes in people's lives. For research teams and clinical staff, this virus has highlighted unknown vulnerabilities and overlooked areas of research. Our understanding of the short and long-term complications of SARS-CoV-2 infection is increasing day by day.[14] SARS-CoV-2 infection is thought to have long-term effects on the cardiovascular system, hepatic system, renal system, endocrine system, nervous system, fertility and mental health in recovered patients.[15] Additionally, this virus has challenged long-held assumptions about the oral cavity.[16] Angiotensin-converting enzyme receptor 2 (ACE2) is one of the main known receptors for SARS-CoV-2.[17] In the oral cavity, ACE2 is expressed in greater abundance in the oral mucosa, especially on the lingual surface and salivary-producing glands, than in the oral or palatal mucosa.[18] Due to this distribution of ACE2, SARS-CoV-2 infection has oral complications such as petechiae, geographic tongue, depapillation, glossitis and necrotizing

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periodontal diseases.[19,20] The relationship between gingivitis, periodontitis, and SARS-CoV-2 has been investigated due to the presence of periodontal diseases among oral manifestations of SARS-CoV-2.[21-23] It has been determined that there is a relationship between periodontitis[24] and severe SARS-CoV-2 and that the probability of developing severe SARS-CoV-2 in patients diagnosed with periodontitis is 2.81 times higher.[23] In addition, another study found that SARS-CoV-2 patients with periodontitis had a higher rate of admission to intensive care units, mortality, and a greater need for ventilation.[25,26] It remains uncertain whether periodontitis directly plays a role in worsening the clinical course of SARS-CoV-2.[24] Hemoglobin-A1c, white blood cells and C-reactive protein are found in higher levels in SARS-CoV-2 patients with periodontitis, resulting in high-risk complications.[27] Oral hygiene and periodontitis treatment are important to help reduce the risk and transmission of SARS-CoV-2 infection.[28] On the other hand, although it is not clear in research whether periodontitis causes SARS-CoV-2 infection, a mutual relationship between the two can be mentioned.[25] There is no clinical study showing whether the incidence of periodontitis in humans changes before and after SARS-CoV-2 infection. Various search engines are valuable for accessing medical information not only for healthcare professionals but also for the general public.[1] Therefore, in this study, we aimed to compare the frequency of people searching for periodontal/periodontitis disease on the internet in some countries before and after SARS-CoV-2 infection. Our aim is to evaluate whether the internet searches for "periodontitis" are different between the period after the first appearance of SARS-CoV-2 infection and the period before.

METHODS

Google Trends and Ethical Approval

Observational, ecological research was conducted in accordance with the Declaration of Helsinki and Google policy. In the study, as in previous studies, ethics committee approval was not sought because the identity information of the individuals searching on the internet was not known. The GT tool is available at http://google.com/trends/ and can be accessed by all internet users. Users can enter their desired keyword (for example, "periodontitis") into the search tab and view the relative search volume (RSV) for their desired region and time frame.

Determination of the Study Group

In the study, searches were conducted using the term "periodontitis" in countries with English as the official language such as the USA, Australia, the United Kingdom, India, and South Africa. In non-English speaking countries like Germany, France, Italy, Russia, Sweden, Saudi Arabia, and Turkiye, searches were conducted using both the term "periodontitis" and its equivalent in the respective languages. For example, when searching for Saudi Arabia, "periodontitis +التهاب" was typed in the GT search section. The term "periodontitis" was searched for in two time periods: four years before and four years after November 2019, when the first case of SARS-CoV-2 was reported in Wuhan, Hubei province, China (given that the SARS-CoV-2 infection occurred four years ago, we chose the four years before it for statistical analysis). Search data (RSV values) were obtained and evaluated accordingly (Figure).

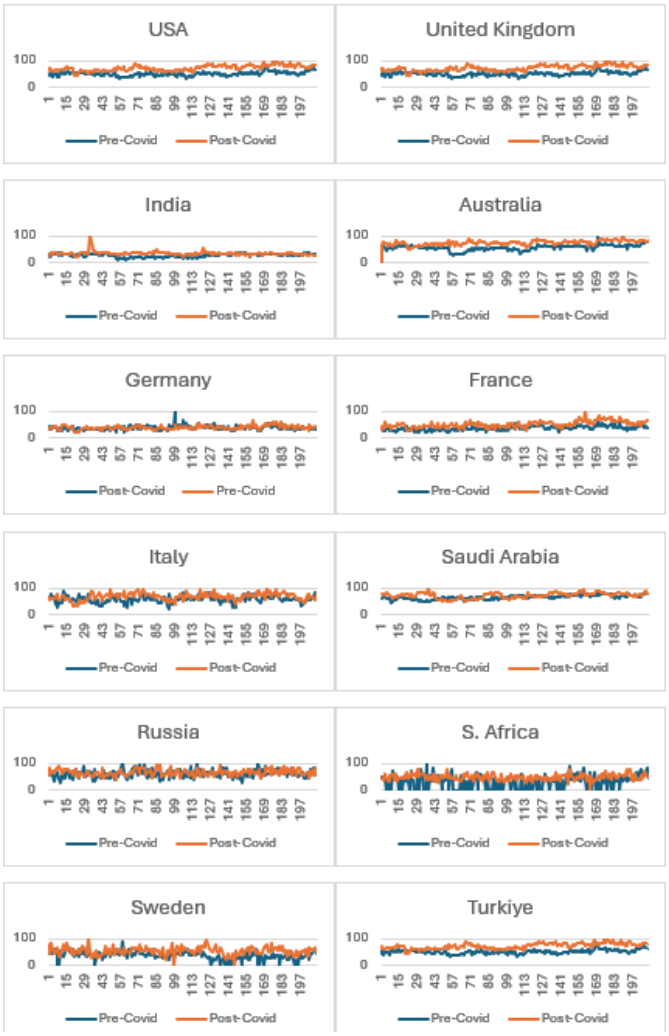

Figure. Graph of RSV values for the word "periodontitis" in the 4-year period before and after November 2019 in USA, Australia, United Kingdom, India, South Africa, Germany, France, Italy, Russia, Sweden, Saudi Arabia and Turkiye

Note: Pre-covid: 4-year period before November 2019, Post-covid: 4-year period after November 2019

Statistical Analysis

Data were analyzed using SPSS software (version 23.0; IBM Corp., Armonk, NY, USA). In this study, mean, standard deviation (SD), median, minimum-maximum and percentage values were given for descriptive statistics. Skewness and Kurtosis values were evaluated to determine whether the data distribution was normal. Kurtosis and skewness values between -1.5 and +1.5 are generally considered to indicate that the data follows a normal distribution.[29] In countries where RSV data is normally distributed, the paired t-test is used to determine the difference between the means of dependent data. For countries where RSV data is not normally distributed, the Wilcoxon test is utilized. For all analyses, $p<0.05$ was considered statistically significant.

RESULTS

Pre SARS-CoV-2 Infection RSV Values

The M (mean) of the RSV data of the word "periodontitis" worldwide in the pre-covid period (between 2015-2019) in Google Trends was calculated as 64.11±7.85. MD (median) was 63, and min and max were calculated as 44 and 100, respectively. M, MD and min-max of RSV values in the pre-covid period were examined and the following data were obtained for each country (Table 1). For USA, M is 56.21±0.69,

Table 1. Means, standard deviations, median and range values of RSV data of USA, Australia, United Kingdom, India, South Africa, Germany, France, Italy, Russia, Sweden, Saudi Arabia and Turkiye

	M		SD		MD		R	
	Pre Cov	Post Cov	Pre Cov	Post Cov	Pre Cov	Post Cov	Pre Cov	Post Cov
USA	56.21	74.40	0.69	0.55	57	75	28-94	50-100
UK	50.03	71.95	0.52	0.70	49	72	30-85	45-100
India	26.36	33.27	0.42	0.49	28	32	9-38	18-100
Germany	37.69	38.56	0.57	0.51	37	39	20-100	20-66
Italy	57.36	67.61	0.83	0.91	58	68	23-90	29-100
Russia	60.79	65.60	1.01	0.81	60	65	26-100	37-97
France	35.93	50.65	0.56	0.82	35	50	18-61	24-100
Australia	53.14	70.86	0.83	0.80	54	70	18-86	44-100
Turkiye	24.98	52.64	1.36	1.21	36	49	0-100	0-80
S. Africa	31.89	48.11	1.66	0.83	28	65	0-73	0-100
Sweden	35.48	53.51	1.09	1.03	37	54	0-89	0-100
S. Arabia	65.40	72.10	0.53	0.70	66	73	46-85	50-100

M: Mean, SD: Standard deviation MD: Median, R: Range

MD is 57 and min-max is 28-94 respectively. For UK, M is 50.03±0.52, MD is 49 and min-max is 30-85 respectively. For Australia, M is 53.14±0.83, MD is 54 and min-max is 18-86 respectively. For India, M is 26.36±0.42, MD is 28 and min-max is 9-38 respectively. For Germany, M is 37.69±0.83, MD is 37 and min-max is 20-100 respectively. For Italy, M is 57.36±0.83, MD is 58 and min-max is 23-90 respectively. For Russia, M is 60.79±1.01, MD is 60 and min-max is 26-100 respectively. For France, M is 35.93±0.56, MD is 35 and min-max is 18-61 respectively. For Turkiye, M is 24.98±1.36, MD is 28 and min-max is 0-73 respectively. For South Africa, M is 31.89±1.66, MD is 36 and min-max is 0-100 respectively. For Sweden, M is 36.11±1.06, MD is 36 and min-max is 0-86 respectively. For Saudi Arabia, M is 65.40±0.53, MD is 66 and min-max is 46-85 respectively.

Post SARS-CoV-2 Infection RSV Values

In the post-covid period worldwide, the M of the RSV value was calculated as 80.80±7.34. The MD was 81, and the min and max were calculated as 58-98, respectively. M, MD and min-max of RSV values in the 209th week of post-covid period were examined and the following data were obtained for each country (Table 1). For USA, M is 74.40±0.55, MD is 75 and min-max is 50-100 respectively. For United Kingdom, M is 71.95±0.70, MD is 72 and min-max is 45-100 respectively. For Australia, M is 70.86±0.80, MD is 72 and min-max is 44-100 respectively. For India, M is 33.27±0.49, MD is 32 and min-max is 18-100 respectively. For Germany, M is 38.56±0.51, MD is 39 and min-max is 20-66 respectively. For Italy, M is 67.61±0.91, MD is 68 and min-max is 29-100 respectively. For Russia, M is 65.60±0.81, MD is 65 and min-max is 37-97 respectively. For France, M is 50.65±0.82, MD is 50 and min-max is 24-100 respectively. For Turkiye, M is 52.64±1.21, MD is 51 and min-max is 0-100 respectively. For South Africa, M is 48.11±0.83, MD is 49 and min-max is 0-80 respectively. For Sweden, M is 53.43±1.07, MD is 53 and min-max is 0-100, respectively. For Saudi Arabia, M is 72.10±0.70, MD is 73 and min-max is 50-100 respectively.

Comparison of Pre-COVID and Post-COVID Period RSV Values

When evaluating the 209-week RSV values globally between the pre-COVID and post-COVID periods, it was found that in the 201st week, the RSV value was higher in the post-COVID period, while in the 6th week, the RSV value was higher in the pre-COVID period. Additionally, in the 2nd week, it was observed that the RSV values were the same in both the pre-COVID and post-COVID periods. There is a significant difference in RSV values between the pre-COVID and post-COVID periods worldwide ($p<0.001$). A significant increase in RSV values has been observed throughout the world in the post-covid period. Additionally, when evaluated separately for the USA, UK, Australia, India, Germany, Italy, Russia, France, Turkiye, and Switzerland, significant differences in RSV values between the pre-COVID and post-COVID periods were observed for all countries ($p<0.001$) (Table 2). RSV values were significantly higher in the post-covid period for all countries.

Table 2. Tests conducted to compare RSV data from USA, Australia, UK, India, South Africa, Germany, France, Italy, Russia, Sweden, Saudi Arabia and Turkiye

	Test	p-value
USA	The paired samples t test	<0.001
UK	Wilcoxon signed ranks test	<0.001
Australia	The paired samples t test	<0.001
India	Wilcoxon signed ranks test	<0.001
Germany	Wilcoxon signed ranks test	<0.001
Italy	The paired samples t test	<0.001
Russia	The paired samples t test	<0.001
France	The paired samples t test	<0.001
Turkiye	The paired samples t test	<0.001
South Africa	The paired samples t test	<0.001
Sweden	The paired samples t test	<0.001
Saudi Arabia	The paired samples t test	<0.001

DISCUSSION

The objective of this study was to assess whether there is a difference in the frequency of internet searches for the term "periodontitis" between the periods before and after the onset of SARS-CoV-2 infection worldwide. The aim was to provide insights that could potentially

guide future clinical research efforts. This study is the first to investigate the word "periodontitis" using GT in the pre- and post-SARS-CoV-2 period. In the study, it was determined that the number of searches for the word "periodontitis" in GT increased significantly in the 4-year period after SARS-CoV-2 infection, worldwide and country-specific, compared to the 4-year period before SARS-CoV-2 infection. This apparent result in our research suggests that periodontitis may be a complication of SARS-CoV-2 infection. As of 29 March 24, 704,533,184 (https://www.worldometers.info/coronavirus/) people worldwide have been exposed to SARS-CoV-2 infection. Numerous studies have demonstrated persistent damage in various organs or systems, including the lungs,[30] heart,[31] kidneys[32] and vascular system,[33] among individuals infected with SARS-CoV-2. The damage appears to result from a severe inflammatory response, thrombotic microangiopathy, venous thromboembolism, and oxygen deprivation.[34,35] In the long term, particles of SARS-CoV-2 persist in a wide variety of organs. It has been shown in studies that even if the virus cannot be detected after SARS-CoV-2 infection and the symptoms of the disease disappear, SARS-CoV-2 does not completely disappear.[36] Stein et al.[37] reported that in a biopsy from a patient who died due to SARS-CoV-2 infection, SARS-CoV-2 RNA was found throughout the body, including brain tissue, for up to 230 days after the onset of symptoms. Lapa et al.[38] reported that in patients who survived and recovered after SARS-CoV-2 infection, hair loss, obesity, memory loss and hypercholesterolemia were observed 3-6 months later, in the period they named as "post-covid syndrome". A recent study conducted by Hany et al.[39] showed that virus particles SARS-CoV-2 form long-term viral reservoirs in the gastrointestinal tract mucosa. The potential for SARS-CoV-2 to create a long-term reservoir and cause damage in the gastrointestinal (GI) mucosa, coupled with one of the entry routes of SARS-CoV-2 being the oral cavity, suggests the possibility of long-term infection in the oral region. One of the main reasons why we conducted this study is that particles of SARS-CoV-2 remain in the mucosa for a long time and cause chronic inflammation in these areas.

Molecules such as ACE-2, furin, cathepsin and TMPRRS, which are important in the entry of SARS-CoV-2 into cells, are found at high levels in periodontal tissues, especially in patients with periodontitis. Additionally, periodontopathic bacteria may play a direct role in the entry mechanism of SARS-CoV-2 by degrading S-protein and cytokines produced during periodontitis.[40] It has been demonstrated that aspiration of periodontal pathogens may increase the severity of SARS-CoV-2 infection in the lungs.[41] It has also been reported that aspiration of saliva with a high viral load may carry the virus to the lower respiratory tract and increase the risk of developing more severe forms of the disease.[42] Numerous studies have investigated the potential presence of a relationship between periodontal diseases and SARS-CoV-2 infection.[21,22,24] Wang et al.[43] investigated the causal relationship between periodontitis and SARS-CoV-2 infection based on MR (Mendelian Randomization) methods and concluded that there is a causal relationship between periodontitis and SARS-CoV-2 infection. In their study, Meng et al.[21] found that periodontitis and GCF (gingival crevicular fluid) IL-1β levels, which are higher in periodontitis, are causally related to increased susceptibility to COVID-19. On the other hand, a study by Drozdzik et al.[22] showed that there was no causal connection between periodontitis and SARS-CoV-2 cases, but it was found that maintaining good periodontal health is positively correlated with the prognosis of the disease in SARS-CoV-2 patients. Marouf et al.[25] reported that patients with periodontitis who have SARS-CoV-2 infection face worse disease outcomes, including a higher risk of admission to intensive care unit, a higher need for ventilation, and a higher mortality rate.

The SARS-CoV-2 pandemic has drastically changed the routine of life and challenged the ways healthcare and dental healthcare are delivered. In most countries, routine dental procedures were suspended during the 1st quarantine.[44] The reason for this could be that dental healthcare workers have been in the highest risk group for contracting SARS-CoV-2 infection during the pandemic, and during this period, dentists may have been more meticulous in adhering to standard protocols. They also reduced working hours and limited dental procedures to emergency treatments to reduce the risk of contracting SARS-CoV-2 infection.[45] According to a study conducted in Beijing, there was a 38% decrease in the number of patients seeking emergency dental treatment in clinics during the SARS-CoV-2 pandemic compared to before the pandemic. Additionally, the ratio of patients visiting clinics for dental issues and oral infections increased from 51% before the pandemic to 71.9% after the outbreak of SARS-CoV-2.[46] According to these studies, it is reported that periodontitis exacerbates the severity of complications from SARS-CoV-2 infection, but it has not been conclusively determined whether SARS-CoV-2 infection directly causes periodontitis. There may be two reasons for the shown increase in the frequency of people searching for the word "periodontitis" on the internet in the period after SARS-CoV-2 infection, both worldwide and on a country basis, compared to the period before SARS-CoV-2 infection. The first reason may be that the SARS-CoV-2 virus causes periodontitis. For this reason, the number of searches for the word "periodontitis" on the internet would have increased in the period after SARS-CoV-2 infection. Second reason may be the suspension of routine dental treatments during the SARS-CoV-2 pandemic, which posed challenges for individuals in accessing dental care. Consequently, this interruption may have contributed to the advancement of gingival diseases and the onset of periodontitis.

The incidence of certain diseases and syndromes has changed following infection with SARS-CoV-2. The strength of this study lies in its status as the first investigation of potential changes in the prevalence of periodontitis. The absence of a clinical design in this investigation may be its major limitation, but the outcomes of forthcoming clinical trials may corroborate the findings of our study.

CONCLUSION

Since the moment the SARS-CoV-2 virus was first seen in the world, the number of searches for the word "periodontitis" on the internet has increased compared to the pre-SARS-CoV-2 period. There may be two potential factors contributing to this phenomenon. The first factor could be the inability of individuals to access routine dental treatments during the period of SARS-CoV-2 infection. The second factor could be the potential of SARS-CoV-2 infection to cause periodontitis.

This conclusion drawn from the study based on internet searches needs further validation through future clinical studies and observations.

ETHICAL DECLARATIONS

Ethics Committee Approval

In the study, as in previous studies, ethics committee approval was not sought because the identity information of the individuals searching on the internet was not known.

Informed Consent

The GT tool is available at http://google.com/trends/ and informed consent is not required as it can be accessed by all internet users.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

Author Contributions

Devrim Deniz Üner and Bozan Serhat İzol contributed equally to the literature review, writing and reviewing the manuscript.

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